

WHAT IS CLAIMED IS:

1 1. A self-assembly method for depositing nanostructure-containing materials, the
2 method comprising:
3 forming a nanostructure-containing material;
4 chemically functionalizing the nanostructure-containing material;
5 dispersing the functionalized nanostructure-containing material in a liquid
6 medium to form a suspension;
7 bringing at least a portion of a substrate having a surface that can attract the
8 functionalized nanostructure-containing material into contact with the suspension; and
9 separating the substrate from the suspension, wherein the nanostructure-
10 containing material adheres to the portion of the substrate when separated from the suspension.

1 2. The method of claim 1, comprising:
2 forming hydrophilic and hydrophobic regions on the surface of the substrate
3 before bringing the substrate into contact with the suspension, wherein the functionalized
4 nanostructure-containing material is hydrophilic and adheres to the hydrophilic region of the
5 substrate when separated from the suspension.

1 3. The method of claim 2, wherein forming hydrophilic and hydrophobic regions
2 comprises:
3 forming on a surface of the substrate a self-assembled monolayer of organosilanes
4 having a hydrophobic end-group termination; and
5 exposing a portion of the self-assembled monolayer to ultraviolet (UV) light in an
6 oxygen environment; wherein the exposed portion of the self-assembled monolayer forms the
7 hydrophilic region of the substrate and the remaining portion of the self-assembled monolayer
8 forms the hydrophobic region of the substrate.

1 4. The method of claim 2, wherein forming hydrophilic and hydrophobic regions
2 comprises:
3 depositing hydrophobic photoresist on the surface of the substrate;
4 exposing a portion of the photoresist to ultraviolet (UV) light; and
5 removing a portion of the photoresist to expose the hydrophilic region of the
6 substrate, wherein the remaining photoresist forms the hydrophobic region of the substrate.

1 5. The method of claim 4, comprising:
2 applying a solvent to the substrate to remove the hydrophobic photoresist after
3 separating the substrate from the suspension, wherein the nanostructure-containing material
4 remains adhered to the substrate after applying the solvent.

1 6. The method of claim 5, comprising:
2 annealing the substrate prior to removing the hydrophobic photoresist.

1 7. The method of claim 2, wherein when the substrate comprises glass, the method
2 comprises:
3 functionalizing a portion of the surface of the glass substrate corresponding to the
4 hydrophilic region of the substrate with organosilanes having an anime end-group termination.

1 8. The method of claim 1, comprising:
2 annealing the substrate after separation from the suspension.

1 9. The method of claim 1, comprising:
2 removing excess nanostructure-containing material from the substrate after
3 separation from the suspension.

1 10. The method of claim 1, comprising:
2 cleaning the substrate prior to bringing the portion into contact with the
3 suspension.

1 11. The method of claim 10, wherein when the substrate comprises glass, cleaning the
2 substrate comprises at least one of:
3 placing the substrate into a sonication bath with a solvent;
4 subjecting the substrate to a mixture of sulfuric acid and hydrogen peroxide; and
5 exposing the substrate to ultraviolet (UV) light in an oxygen environment.

1 12. The method of claim 1, wherein bringing the substrate into contact with the
2 suspension comprises:
3 immersing the substrate in the nanostructure-containing suspension.

1 13. The method of claim 12, wherein separating the substrate from the suspension
2 comprises at least one of:

3 withdrawing the immersed substrate from the suspension; and
4 evaporating the suspension while the substrate is immersed.

1 14. The method of claim 1, wherein bringing the substrate into contact with the
2 suspension comprises:

3 arranging the suspension on a portion of the surface of the substrate; and
4 moving the suspension across the surface of the substrate, wherein the
5 nanostructure-containing material dispersed in the suspension adheres to the surface that can
6 attract the functionalized material.

1 15. The method of claim 1, wherein bringing the substrate into contact with the
2 suspension comprises at least one of spin-coating and spraying the nanostructure-containing
3 suspension onto the substrate.

1 16. The method of claim 1, wherein the liquid medium comprises water to form an
2 aqueous nanostructure-containing suspension.

1 17. The method of claim 1, wherein a concentration of material included in the
2 suspension is between about .0001 to 1 gram of nanostructure-containing material per liter of
3 liquid medium.

1 18. The method of claim 1, wherein the nanostructure-containing material comprises
2 at least one of single-walled carbon nanotubes, multi-walled carbon nanotubes, silicon, silicon
3 oxide, germanium, germanium oxide, carbon nitrides, boron, boron nitride, dichalcogenide,
4 silver, gold, iron, titanium oxide, gallium oxide, indium phosphide, and magnetic particles
5 including at least one Fe, Co, and Ni enclosed within nanostructures.

1 19. The method of claim 1, wherein chemically functionalizing the nanostructure-
2 containing material comprises:
3 partially oxidizing the nanostructure-containing material by reaction with an acid.

1 20. The method of claim 1, wherein the substrate comprises at least one of silicon,
2 glass, indium-tin-oxide (ITO) coated glass, a metal, metal-coated glass, a plastic, and a ceramic.

1 21. The method of claim 1, wherein the nanostructure-containing material adhered to
2 the substrate is substantially aligned in one direction.

1 22. A method of fabricating a patterned carbon nanotube field emission cathode by
2 self-assembly, the method comprising:
3 forming a material comprising carbon nanotubes;
4 chemically functionalizing the carbon nanotubes;
5 dispersing the material comprising the functionalized carbon nanotubes in a liquid
6 medium to form a suspension;
7 forming hydrophilic and hydrophobic regions on a surface of a substrate that can
8 attract the functionalized carbon-nanotubes;
9 bringing at least a portion of the substrate into contact with the suspension; and
10 separating the substrate from the suspension, wherein the carbon nanotubes
11 adhere to the hydrophilic region of the substrate when separated from the suspension.

1 23. The method of claim 22, comprising:
2 annealing the substrate after separation from the suspension; and
3 removing excess carbon nanotubes from the substrate after separation from the
4 suspension.

1 24. The method of claim 22, wherein chemically functionalizing the carbon
2 nanotubes comprises:
3 partially oxidizing the carbon nanotubes by reaction with an acid.

1 25. A field emission cathode produced in accordance with the method of claim 1.

1 26. A field emission cathode produced in accordance with the method of claim 22.

1 27. An apparatus for depositing nanostructure-containing materials on a substrate, the
2 apparatus comprising:

3 means for forming a nanostructure-containing material;

4 means for chemically functionalizing the nanostructure-containing material;

5 means for dispersing the functionalized nanostructure-containing material in a
6 liquid medium to form a suspension;

7 means for bringing at least a portion of the substrate having a surface that can
8 attract the functionalized nanostructure-containing material into contact with the suspension; and

9 means for separating the substrate from the suspension, wherein the
10 nanostructure-containing material adheres to the portion of the substrate when separated from the
11 suspension.

1 28. The apparatus of claim 27, comprising:

2 means for forming hydrophilic and hydrophobic regions on the surface of the
3 substrate before bringing the substrate into contact with the suspension, wherein the

4 functionalized nanostructure-containing material is hydrophilic and adheres to the hydrophilic
5 region of the substrate when separated from the suspension.